What is claimed is:

[Claim 1] 1. A thermal barrier coating on a surface of a substrate, the thermal barrier coating being formed of at least one ceramic material and having a columnar microstructure comprising columns extending from the surface of the substrate, the columns having inner regions contacting the surface of the substrate, outer regions near an outermost surface of the thermal barrier coating, and interior regions therebetween, the inner regions of the columns being substantially normal to the surface of the substrate and at least one of the interior and outer regions of the columns being nonaligned with their respective inner regions so that the columns of the columnar microstructure are continuous but modulated between the inner and outer regions to reduce tensile stresses within the columns resulting from particle impact such that cracking of the columns from particle impact is more likely to occur within the outer regions of the columns as compared to the inner regions of the columns.

[Claim 2] 2. A thermal barrier coating according to claim 1, wherein the thermal barrier coating is characterized by the substantial absence of columns that are discontinuous between the surface of the substrate and the outermost surface of the thermal barrier coating, whereby the inner, interior and outer regions are not discrete layers and are not separated by distinct interfaces.

[Claim 3] 3. A thermal barrier coating according to claim 1, wherein adjacent pairs of the columns are substantially equally spaced from each other along the inner, interior and outer regions thereof.

[Claim 4] 4. A thermal barrier coating according to claim 1, wherein the surface of the substrate is defined by a metallic bond coat that promotes adhesion of the thermal barrier coating to the substrate.

[Claim 5] 5. A thermal barrier coating according to claim 1, wherein the ceramic material within the inner, interior and outer regions has the same composition.

[Claim 6] 6. A thermal barrier coating according to claim 5, wherein the ceramic material consists essentially of zirconia and yttria.

[Claim 7] 7. A thermal barrier coating according to claim 1, wherein the ceramic material of at least one of the inner, interior and outer regions is chosen from the group consisting of ceramic materials having a lower thermal conductivity than zirconia stabilized by seven weight percent yttria, ceramic materials having greater CMAS-resistance than zirconia stabilized by seven weight percent yttria, and ceramic materials having greater erosion resistance than zirconia stabilized by seven weight percent yttria.

[Claim 8] 8. A thermal barrier coating according to claim 1, wherein the substrate is a gas turbine engine component.

[Claim 9] 9. A thermal barrier coating according to claim 8, wherein the component is a turbine blade.

[Claim 10] 10. A thermal barrier coating according to claim 8, wherein the component is a vane.

[Claim 11] 11. A thermal barrier coating according to claim 10, wherein the surface of the substrate is a leading edge of the component.

[Claim 12] 12. A coating system on a surface of a gas turbine engine component, the coating system comprising a bond coat on the surface and a thermal barrier coating on the bond coat, the thermal barrier coating being formed of a ceramic material and having a columnar microstructure comprising columns extending from the surface of the component, the columns having inner regions contacting the surface of the component, outer regions at an outermost surface of the thermal barrier coating, and interior regions therebetween, the ceramic material within the inner, interior and outer regions substantially having the same composition, the inner regions of the columns being substantially normal to the surface of the substrate and at least one of the interior and outer regions of the columns being nonaligned with their respective inner regions so that the columns of the columnar microstructure are continuous but modulated between the inner and outer regions to reduce tensile stresses within the columns resulting from particle impact such that cracking of the columns from particle impact is more likely to occur within the outer regions of the columns as compared to the inner regions of the columns.

[Claim 13] 13. A coating system according to claim 12, wherein the thermal barrier coating is characterized by the substantial absence of columns that are discontinuous between the surface of the component and the outermost surface of the thermal barrier coating, whereby the inner, interior and outer regions are not discrete layers and are not separated by distinct interfaces.

[Claim 14] 14. A coating system according to claim 12, wherein adjacent pairs of the columns are substantially equally spaced from each other along the inner, interior and outer regions thereof.

[Claim 15] 15. A coating system according to claim 12, wherein the ceramic material consists essentially of zirconia and yttria.

[Claim 16] 16. A coating system according to claim 12, wherein the ceramic material of at least one of the inner, interior and outer regions is chosen from the group consisting of ceramic materials having a lower thermal conductivity than zirconia stabilized by seven weight percent yttria, ceramic materials having greater CMAS-resistance than zirconia stabilized by seven weight percent yttria, and ceramic materials having greater erosion resistance than zirconia stabilized by seven weight percent yttria.

[Claim 17] 17. A coating system according to claim 12, wherein the component is a turbine blade.

[Claim 18] 18. A coating system according to claim 12, wherein the component is a vane.

[Claim 19] 19. A coating system according to claim 12, wherein the surface of the component is a leading edge of the component.

[Claim 20] 20. A method of depositing a thermal barrier coating on a surface of a component, the method comprising depositing a ceramic material on the surface to form the thermal barrier coating with a columnar microstructure comprising columns extending from the surface of the component, the columns having inner regions contacting the surface of the component, outer regions near an outermost surface of the thermal barrier coating, and interior regions therebetween, the inner regions of the columns being substantially normal to the surface of the substrate and at least one of the interior and outer regions of the columns being nonaligned with their respective inner regions so that the columns of the columnar microstructure are continuous but modulated between the inner and outer regions to reduce tensile stresses within the columns resulting from particle impact such that cracking of the columns from particle impact is more likely to occur within the outer regions of the columns as compared to the inner regions of the columns.

[Claim 21] 21. A method according to claim 20, wherein the depositing step is a continuous line-of-sight vapor deposition process comprising at least first, second and third phases that form the inner, interior and outer regions, respectively, of the thermal barrier coating, the component being rotated about an axis or rotation thereof during the depositing step, the component being initially oriented during the first phase relative to a source of the ceramic material so that the axis of rotation of the component is substantially perpendicular to a direction of vapor flow from the source, during at least one of the second and third phases the component having an orientation that differs from at least the first phase to create the nonalignment of at least one of the interior and outer regions of the columns.

[Claim 22] 22. A method according to claim 20, wherein the component is rotated about an axis of rotation thereof during the depositing step.

[Claim 23] 23. A method according to claim 22, wherein rotation of the component is continuous and in a single rotational direction throughout the depositing step.

[Claim 24] 24. A method according to claim 23, wherein the component is intermittently oscillated during the depositing step.

[Claim 25] 25. A method according to claim 23, wherein the axis of rotation of the component is held at a horizontal position during a first phase of the depositing step, oscillated between the horizontal position and a first angle in a first direction from the horizontal position during a second phase of the depositing step, held at the horizontal position during a third phase of the depositing step, and then oscillated between the horizontal position and a second angle in an oppositely-disposed second direction from the horizontal position during a fourth phase of the depositing step.

[Claim 26] 26. A method according to claim 23, wherein the axis of rotation of the component is held at a horizontal position during a first phase of the depositing step, oscillated to and held at a first angle in a first direction from the horizontal position during a second phase of the depositing step, and then oscillated to and held at a second angle in an oppositely-disposed second direction from the horizontal position during a third phase of the depositing step.

[Claim 27] 27. A method according to claim 26, wherein the first and second angles are substantially equal but in opposite directions.

[Claim 28] 28. A method according to claim 23, wherein the axis of rotation of the component is held at a horizontal position during a first phase of the depositing step, oscillated to and held at a first angle in a first direction from the horizontal position during a second phase of the depositing step, oscillated to and then held at the horizontal position during a third phase of the depositing step, oscillated to and held at a second angle in an oppositely-

disposed second direction from the horizontal position during a fourth phase of the depositing step, and then oscillated to and held at the horizontal position during a fifth phase of the depositing step.

[Claim 29] 29. A method according to claim 28, wherein the first and second angles are substantially equal but in opposite directions.

[Claim 30] 30. A method according to claim 28, wherein the steps of oscillating the component to the horizontal position during the third and fifth phases of the depositing step are performed over an extended interval of form waves in the columns of the thermal barrier coating.

[Claim 31] 31. A method according to claim 22, wherein rotation of the component is periodically reversed to occur in two opposite rotational directions during the depositing step.

[Claim 32] 32. A method according to claim 31, wherein the component is rotated in a first rotational direction while its axis of rotation is held at a horizontal position during a first phase of the depositing step, oscillated between the horizontal position and a first angle in a first direction from the horizontal position while continuing to rotate in the first rotational direction during a second phase of the depositing step, and held at the horizontal position while being alternately rotated in the first rotational direction and an opposite second rotational direction during a third phase of the depositing step.

[Claim 33] 33. A method according to claim 31, wherein the component is rotated through a first rotational angle in a first rotational direction during a first phase of the depositing step, held and not rotated during a second phase

of the depositing step, and further rotated through the first rotational angle in the first rotational direction during a third phase of the depositing.

[Claim 34] 34. A method according to claim 33, wherein the component is not oscillated during the depositing step.

[Claim 35] 35. A method according to claim 20, wherein as a result of the depositing step the thermal barrier coating is characterized by the substantial absence of columns that are discontinuous between the surface of the component and the outermost surface of the thermal barrier coating, whereby the inner, interior and outer regions are not discrete layers and are not separated by distinct interfaces.

[Claim 36] 36. A method according to claim 20, wherein as a result of the depositing step adjacent pairs of the columns are substantially equally spaced from each other along the inner, interior and outer regions thereof.

[Claim 37] 37. A method according to claim 20, wherein the same ceramic material is deposited throughout the depositing step so that the inner, interior and outer regions have the same composition.

[Claim 38] 38. A method according to claim 20, wherein the ceramic material consists essentially of zirconia and yttria.

[Claim 39] 39. A method according to claim 20, wherein the ceramic material of at least one of the inner, interior and outer regions is chosen from the group consisting of ceramic materials having a lower thermal conductivity than zirconia stabilized by seven weight percent yttria, ceramic materials having greater CMAS-resistance than zirconia stabilized by seven weight

percent yttria, and ceramic materials having greater erosion resistance than zirconia stabilized by seven weight percent yttria.

[Claim 40] 40. A method according to claim 20, wherein the component is a gas turbine engine component.

[Claim 41] 41. A method according to claim 40, wherein the component is a turbine blade.

[Claim 42] 42. A method according to claim 40, wherein the component is a turbine vane.

[Claim 43] 43. A method according to claim 40, wherein the surface of the component is a leading edge of the turbine blade.